Table 2-1. Physical properties of a shallow sedimentary interbed at CFA Landfills II and III (Stephens and Associates 1993).

Location	Depth (ft)	Particle Density (g/cm^3)	Bulk Density (g/cm^3)	CEC (meq/100g)	Organic Carbon (%)	Inorganic Carbon (%)	Particle Size		
							Gravel (%)	Sand (%)	Silt and Clay (%)
LF2-12	48.0–50.3	2.66	1.56	6.8	<0.1	1.0	0.57	97.43	2.00
LF2-12	53.5–55.8	2.7	1.48	4.1	<0.1	0.7	2.56	93.44	17.00
LF2-12	57.1–59.4	2.7	1.77	7.1	0.3	10.3	17.27	65.73	4.00
LF2-12A	46.0–47.5	2.73	1.56	5.3	0.1	3.0	0	100	0
LF2-12A	47.5–48.5	2.79	1.65	6.7	0.1	1.7	76.41	20.59	3.00
LF2-12A	48.5–50.5	2.76	1.71	11.6	<0.1	5.9	1.02	44.98	54.00
LF3-10	60.2–61.0	3.02	1.76	5.3	0.1	6.5	69.05	29.95	1.00
LF3-10	64.4–65.15	2.66	1.76	4.5	0.1	2.9	34.84	63.16	2.00
LF3-10	65.5–67.25	2.67	1.92	5.0	<0.1	3.9	32.92	67.08	0
Average		2.74	1.69	6.27					
Standard Deviation		0.11	0.14	2.26					

Table 2-2. Depths of clay in sedimentary interbeds observed in monitoring wells at CFA Landfills II and III.

Landfill	Monitoring Well	Depth Interval of Clay Layer (ft bgs)[a]	Material[b]
II	LF2-08	185–200	Clay
		372–385	Sandy, clayey silt
	LF2-09	45–65	Sand, clay
		370–385	Silt and clay
		625–645	Silt and clay
	LF2-10	50–65	Clay with trace of silt and sand
		148–149	Clay
	LF2-12	195–197	Clay, sandy
III	LF3-08	150–167	Silt/clay
		185–200	Silt/clay
	LF3-10	55–70	Sand, cinders changing to sand with 25% clay
		90–97	Sand with 20% clay
		150–190	Sand with 0–3% clay
		240–250	Sand with 20–30% clay
	LF3-11	405–415	Sand with silt and clay
	LF3-11	128–135	Clay, wilty with basalt
		190–192	Clay/silt
		352–362	Sand, clay
		410–420	Sand with clay and silt
	USGS-85	55–65	Clay
		95–100	Clay and basalt
		145–165	Basalt and clay
		170–200	Basalt and clay
		298–302	Clay
		345–355	Clay
		515–520	Broken basalt and clay
		612–622	Clay

a. Depths are approximate.

b. The classification of the soil materials is based on a geologist field observations made during drilling.

2.4 Hydrology

This section provides an overview of the hydrology at the INEEL and WAG 4.

2.4.1 Surface Water Hydrology

Surface water on the INEEL consists mainly of three streams draining from intermountain valleys to the north and northwest: the Big Lost River, the Little Lost River, and Birch Creek (Figure 2-8). Water flowing onto the INEEL, either evaporates or infiltrates into the ground because the basin is a closed topographic depression.

Streamflows from the Little Lost River that reach the INEEL have no effect on CFA. The Big Lost River streamflows are also often depleted by irrigation diversions and infiltration losses along the river before reaching the INEEL. Prior to 1993, the Big Lost River had not flowed onto the INEEL since 1986, partly due to the prolonged drought conditions in southeastern Idaho over the previous five years, in addition to the increased upstream irrigation demands. When flow in the Big Lost River actually reaches the INEEL, it is either diverted at a diversion dam (Figure 2-8) or flows northward across the INEEL in a shallow, gravel-filled channel to its terminus at the Lost River sinks where its flow is lost to evaporation and infiltration.

The Big Lost River is approximately 2.4 km (1.5 mi) northwest of CFA at its nearest point. There is no potential impact on the Big Lost River as runoff from CFA infiltrates the desert floor with no discharge to the Big Lost River. Groundwater beneath CFA is approximately 146 m (480 ft) below land surface.

Other sources of surface water on the INEEL consist of precipitation in the form of rain or snow and the subsequent melting of the snow. Precipitation on the INEEL is light and there is little runoff, even locally, except during heavy rainstorms or rapid snow melting (Nace et al. 1956). The evapotranspiration rates are greater than 80% of the available water; therefore, very little water is available to infiltrate the surface soil cover or to provide significant runon/runoff (Anderson et al. 1987).

2.4.2 Regional Groundwater Hydrology

The SRPA, one of the largest and most productive groundwater resources in the United States, underlies the INEEL and is listed as a Class I aquifer. The EPA designated the SRPA as a sole source aquifer under the Safe Drinking Water Act on October 7, 1991. As a result of this determination, Federal financially assisted projects proposed over the SRPA are subject to EPA review to ensure these projects are designed and constructed to protect water quality.

The SRPA consists of a series of saturated basalt flows and interlayered pyroclastic and sedimentary materials that underlie the ESRP. The SRPA is approximately 325 km (200 mi) long, 80 to 112 km (50 to 70 mi) wide, and covers an area of approximately 25,000 km^2 (9,600 mi^2). It extends from Hagerman, Idaho on the west to near Ashton, Idaho, northeast of the INEEL.

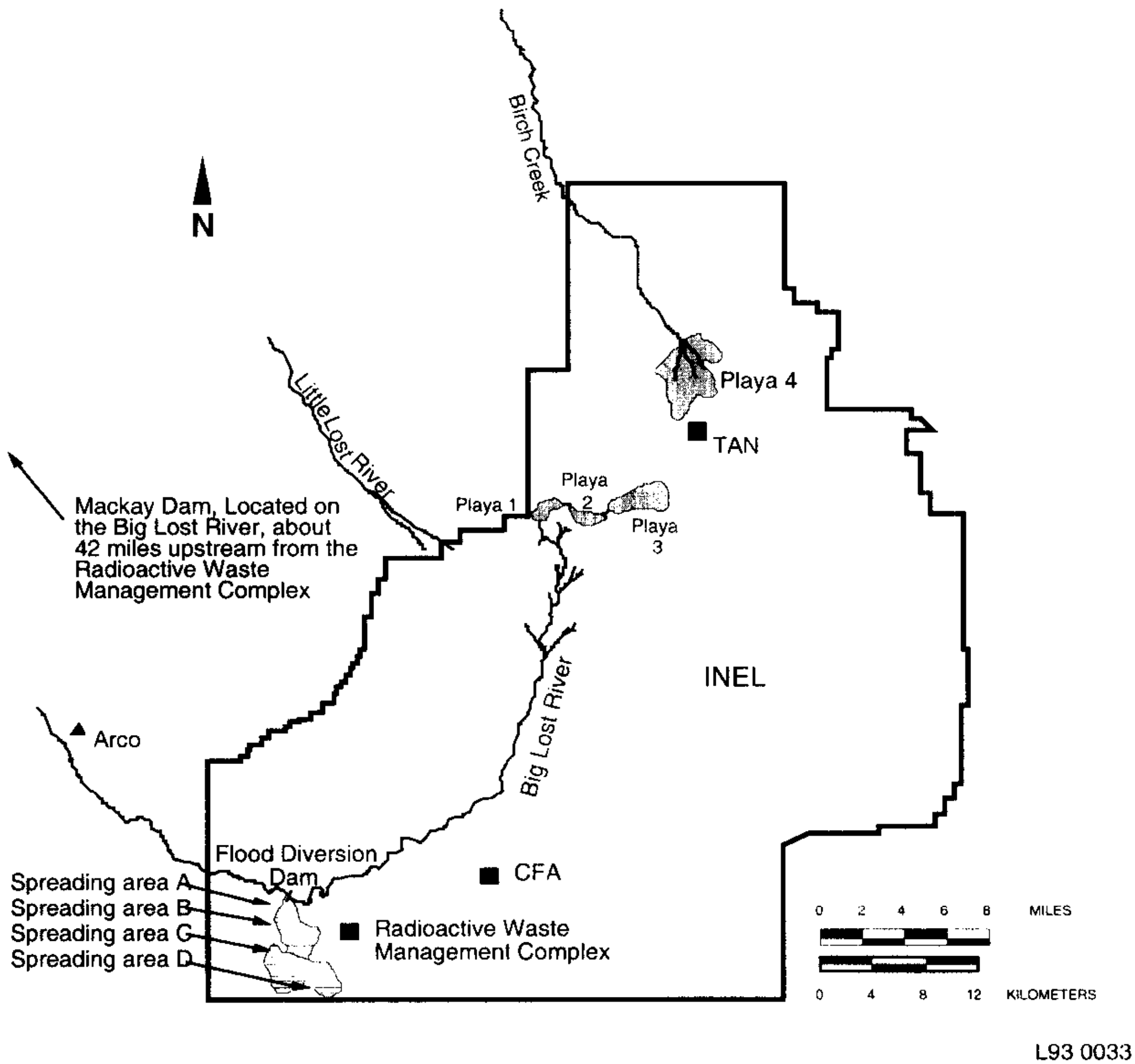

Figure 2-8. Map showing surface water features near or on the INEEL (L93 0033).

Groundwater elevation contours for the SRPA beneath the INEEL are depicted on Figure 2-9. The regional flow beneath the INEEL is south-southwest, although the local direction of groundwater flow may be affected by recharge from streams, surface water spreading areas, and inhomogeneities in the aquifer. Across the southern INEEL, the average gradient of the water table is approximately 0.38 m/km (2 ft/mi) or 0.00038 m/m (0.00038 ft/ft) (Lewis and Goldstein 1982). Depth to water varies from approximately 61 m (200 ft) in the northeast corner of the INEEL to 305 m (1,000 ft) in the southeast corner.

Robertson et al. 1974 estimated that as much as 2.5×10^{12} m^3 (2 billion acre-ft) of water may be stored in the aquifer; approximately 6.2×10^{11} m^3 (500 million acre-ft) are recoverable. Later estimates suggest that the aquifer contains approximately 4.9×10^{11} m^3 (400 million acre-ft) of water in storage. The aquifer discharges approximately 8.8×10^{9} m^3 (7.1 million acre-ft) of water annually to springs and

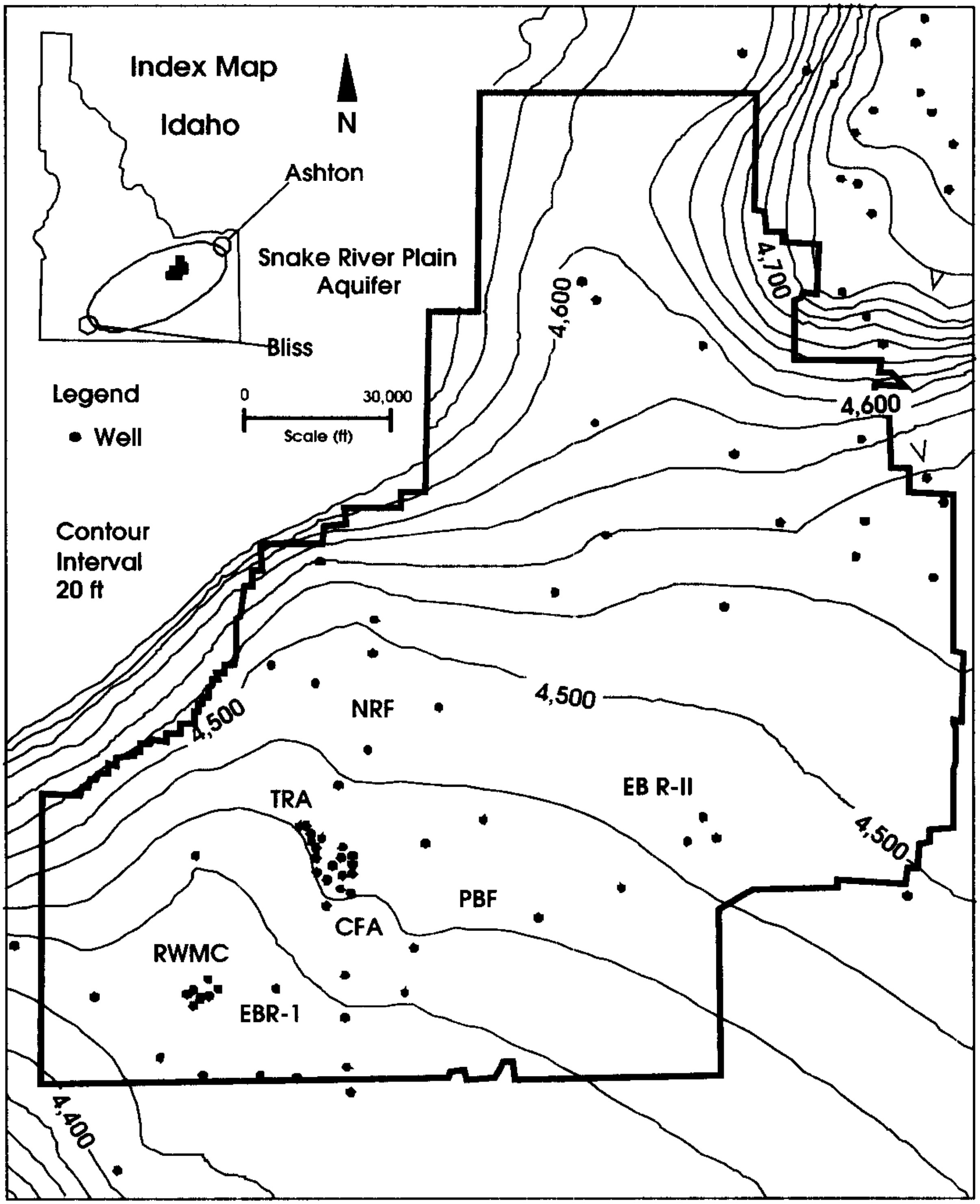

Figure 2-9. Groundwater elevation of SRPA (J960145).

rivers. Pumpage from the aquifer for irrigation totals approximately 2.0×10^9 m^3 (1.6 million acre-ft) annually (Hackett et al. 1986).

Recharge to the SRPA from within INEEL boundaries is primarily in the form of infiltration from the rivers and streams draining the areas to the north, northwest, and northeast of the ESRP. In most years, spring snowmelt produces surface runoff that accumulates in depressions in the basalt or in playa lakes. On the INEEL, water not lost to evapotranspiration recharges the aquifer because the INEEL is in a closed topographic depression. Significant recharge from high runoff in the Big Lost River causes a regional rise in the water elevations over much of the INEEL. Water levels in wells in the vicinity of the Big Lost River have been documented to rise as much as 1.8 m (6 ft) following very high river flows (Pittman et al. 1988).

Aquifer tests have been conducted on wells completed in the SRPA to determine the wells' suitability for water supply and to support regional studies conducted by the United States Geological Survey (USGS; Mundorff et al. 1964; Robertson et al. 1974; Wood 1989; Ackerman 1991). Ackerman's transmissivity calculations range from a low of 0.9 m^2/day (10 ft^2/day) in USGS-114 to a high of 68,400 m^2/day (760,000 ft^2/day) in CPP-4, which is a variation of more than four orders of magnitude. The median value is 5,040 m^2/day (56,000 ft^2/day) at USGS-82. This is much lower than the 24,300 to 36,000 m^2/day (270,000 to 400,000 ft^2/day) transmissivity estimated for the regional aquifer at the INEEL. This may be due to the short open interval in the wells rather than a local decrease in transmissivity. None of the wells tested fully penetrate the aquifer; therefore, the transmissivity of the local aquifer in the vicinity of CFA may be somewhat higher. The results of the aquifer tests demonstrate that the aquifer is not homogeneous and isotropic, and that there is considerable variation in the transmissivity and hydraulic conductivity at CFA (Table 2-3).

2.4.3 Groundwater Hydrology at WAG 4

The USGS has maintained a groundwater monitoring network at the INEEL to characterize the occurrence, movement, and quality of water and to delineate the movement of facility-related wastes in the SRPA since 1949. This network consists of a series of wells from which periodic water-level and water-quality data are obtained. Data from the monitoring network are on file at the USGS's INEEL Project Office. Nine groundwater monitoring wells were installed in the northern portion of CFA. The wells were installed to monitor the CFA landfills at both upgradient and downgradient locations. The depth to water in these wells varies from approximately 145 m (476 ft) at LF2-8 to just over 150 m (495 ft) at LF3-8. The hydraulic gradient for the regional aquifer in the vicinity of CFA is approximately 0.2 m/km (1 ft/mi) (Lewis and Jensen 1984). Aquifer storativity was calculated in the vicinity of the CFA landfills using wells LF2-11 and LF3-11 based on barometric efficiency and provided an estimate of 0.0003.

Water in the SRPA shows a chemical composition reflecting the source area of the recharge (Robertson et al. 1974). Recharge from the north and northwest is derived from clastic and carbonate sedimentary rocks and is, therefore, a calcium bicarbonate-type water. Recharge from the east is derived from silicious volcanic rocks and is somewhat higher in sodium, fluoride, and silica. Groundwater at the CFA landfills is of the calcium bicarbonate-type indicative of recharge from the north and northwest.

Documented instances of groundwater degradation at the INEEL have occurred from past waste disposal practices and have had measurable effects on groundwater concentrations in the vicinity of CFA. Radionuclide and chemical constituents detected in the SRPA include tritium, strontium-90, cobalt-60, cesium-137, plutonium-238, plutonium-239, plutonium-240 (undivided), americium-241, total chromium,

Table 2-3. Transmissivity values for wells in the WAG 4 area, based on pumping test evaluations.[a]

Well Name	Completion Zone (ft bgs)	Date of Test	Transmissivity (ft^2/day)
CFA-2	521–651 661–681	2/27/51	170
CPP-1	459.9–485.9 527.4–576.8	8/12/81	73,000
CPP-2	458.3–483.3 551.1–600.25	8/14/81	160,000
CPP-3	412–452 490–593	9/27/51	760,000
USGS-37	507–571.5	7/7/87	16,000
USGS-40	456–678.8	7/28/87	87,000
USGS-43	450.5–675.8	7/29/87	80,000
USGS-51	475–659	6/26/87	2,900
USGS-57	477–732	6/24/87	28,000
USGS-76	457–718	6/10/87	190,000
USGS-82	469–561	6/26/87	56,000
USGS-111	440–600	5/20/87	22
USGS-112	432–563	5/26/87	64,000
USGS-113	445–564	6/1/87	190,000
USGS-114	440–564	5/21/87	10
USGS-115	440–581	5/22/87	32
USGS-116	400–580	5/29/87	150

a. Ackerman (1991).

sodium, chloride, nitrate, and trichloroethene (Orr and Cecil 1991). Tritium and chromium have been detected in the groundwater collected from monitoring wells upgradient and downgradient of CFA. A major source of this groundwater contamination is due to past waste disposal practices at INTEC and TRA, two facilities upgradient of CFA. From 1952 to 1988, approximately 30,900 Ci of tritium contained in waste water from INTEC and TRA operations were disposed to wells and infiltration ponds at these facilities (Mann and Cecil 1990). For example, from 1952 to 1964, an estimated 11,000 kg (24,318 lb) of chromium were contained in wastewater disposed to an unlined infiltration pond at TRA and from 1965 to 1972, an estimated 14,100 kg (31,161 lb) of chromium were contained in wastewater injected directly into the SRPA through a disposal well at TRA (Mann and Knobel 1988).

Dedicated sampling pumps in the landfill monitoring wells, which were manufactured in part with high-chromium stainless steel, introduced particulate chromium into samples collected from these wells during previous groundwater sampling events in 1989 and 1990. The dedicated sampling pumps were removed from the monitoring wells prior to sampling these wells in the 1993 OU 4-12 RI. Data collected from these wells indicate that chromium concentrations are below the maximum contaminant level (MCL) of 100 μg/L with an average concentration of 11 μg/L. Data collected from these wells indicates that there is no significant difference in concentration between upgradient and downgradient wells.

The sources of drinking water for site employees at CFA consist of two production wells (CFA-1 and CFA-2). A drinking water program was initiated in 1988 to monitor drinking water wells on the INEEL for compliance with community water system standards as established by EPA and State of Idaho regulations, as well as applicable DOE orders. Samples collected from CFA-1 and –2 production wells are analyzed for radionuclides (gross alpha, beta, and tritium), organics, inorganics (nitrates), and metals.

2.4.4 Perched Water at CFA

Two perched water zones existed beneath the sewage treatment plant drainfield (OU 4-08) from 1944 through 1995. These zones were the result of waste water discharged to the sewage treatment plant drainfield during this period. The average flow rates vary from 662,375 L (175,000 gal) to 757,000 L (200,000 gal/day) during the summer and 416,350 L (110,000 gal)/day during the winter. The sewage treatment plant and drainfield were deactivated in 1995. The lower perched water zone has since dissipated as evidenced in June 1996 when no water was found in the well. The upper perched water has also dissipated as evidenced in January 1997, when no water was found in the well.

2.5 Ecology

A thorough discussion of the ecology of WAG 4 is contained in Section 7 of this report, "WAG 4 Ecological Risk Assessment."

2.6 Demography and Land Use

2.6.1 Demography

The INEEL consists of 2,305 km^2 (890 mi^2) of Federally owned land that has been withdrawn from public use by DOE. The INEEL is a controlled access area where only employees and approved contractor personnel are allowed. Public access to the INEEL is limited to two Federal highways and three state highways. Other roads within the INEEL boundary are restricted to personnel and visitors on official business. There are approximately 5,000 employees on the INEEL during the day; approximately 820 of those are at CFA. The mission of CFA is to provide efficient, centralized support services for programmatic and nonprogrammatic efforts of all INEEL contractors and DOE. The support services provided include warehousing, craft shops, research laboratories, administrative offices, and landfills.

The INEEL is contained within five counties: Bingham (39,613 population), Bonneville (77,395), Butte (2,940), Clark (798), and Jefferson (17,486) (Figure 2-10). Major communities include Blackfoot and Shelley in Bingham County, Ammon and Idaho Falls in Bonneville County, Arco in Butte County, and Rigby in Jefferson County. The nearest community to the INEEL is Atomic City, located south of the INEEL border on Highway 26. Other population centers near the INEEL include Howe, west of the Site on U.S. Highway 22/33; and Mud Lake and Terreton on the INEEL's northeast border, 17.6 km (11 mi) east of TAN.

2.6.2 Land Use

2.6.2.1 Current. The BLM has classified the acreage within the INEEL as industrial and mixed use (DOE 1996). It is used as a nuclear research, materials, and development facility. The INEEL was designated as a National Environmental Research Park in 1975. As such, it is used as a controlled outdoor laboratory, where scientists can study changes in the natural environment caused by human activities.

The developed area within the INEEL is surrounded by a 1,295 km^2 (500 mi^2) buffer zone of grazing land for cattle and sheep (DOE 1996). Grazing areas at the INEEL, shown in Figure 2-11, are administered by the BLM. Because of dry conditions, cattle have been grazed on-Site in the past few years. During selected years, depredation hunts of game animals, managed by the Idaho Department of Fish and Game, are permitted on-Site. Hunters are allowed in a hunting zone that extends 0.8 km (0.5 mi) inside the INEEL boundary on portions of the northeast and west borders of the Site.

State Highways 22, 28, and 33 cross the northeastern portion of the Site, and U.S. Highways 20 and 26 cross the southern portion (Figure 2-11). State Highway 33 crosses the TAN area immediately southeast of TSF. There are a total of 145 km (90 mi) of paved highways used by the general public that pass through the INEEL (DOE 1996). Fourteen miles of the Union Pacific Railroad traverse the southern portion of the Site. A government-owned railroad passes from the Union Pacific Railroad line through CFA to the Naval Reactor Facility. A spur runs from the Union Pacific Railroad line to the RWMC. Land ownership distribution in the vicinity of the INEEL and on-site areas are open for grazing under a permit system. In the counties surrounding the INEEL, approximately 45% of the land is used for agriculture, 45% is open land, and 10% is urban. Agricultural uses include production of sheep, cattle, hogs, poultry, and dairy cattle (Bowman et al. 1984). Crops grown include potatoes, sugar beets, wheat, barley, oats, forage, and seed crops. Most of the land surrounding the INEEL is owned by private individuals or the U.S. Government (administered by the BLM) (Figure 2-11).

2.6.2.2 Future. Future land use at the INEEL will most likely remain industrial. CFA facilities are planned to continue with new industrial development through the 100 year time-frame and will be used as the central support facility for the INEEL (DOE 1996). Future uses of the land utilized by the INEEL may include agriculture, residential, or return of the land to an undeveloped state. The human health risk assessment, presented in Section 6 of this document, evaluates potential risks from site contaminants using the residential exposure scenario which starts at the end of the 100-year time-frame. This scenario is the most conservative of other possible scenarios (i.e., industrial).

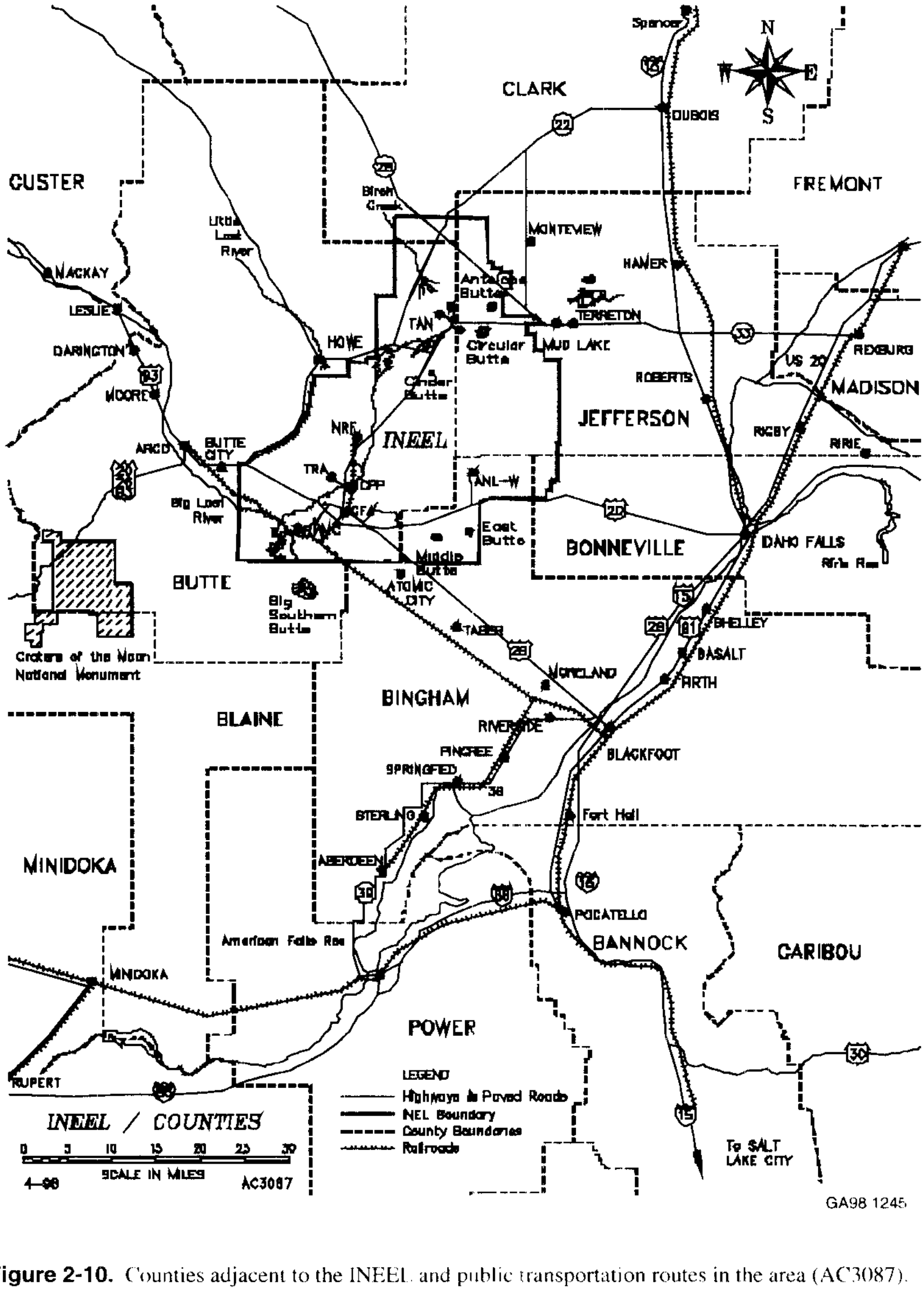

Figure 2-10. Counties adjacent to the INEEL and public transportation routes in the area (AC3087).

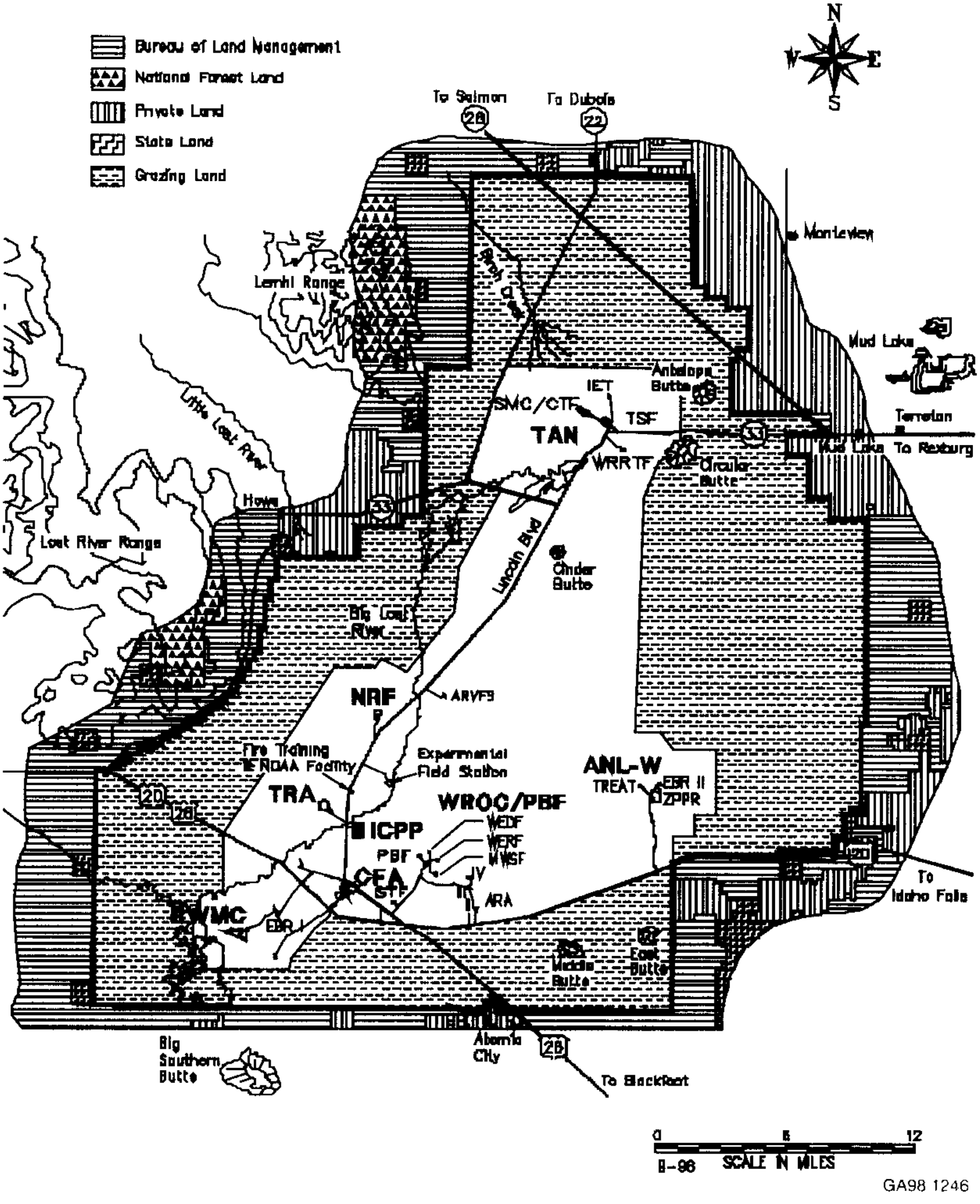

Figure 2-11. Land ownership distribution in the vicinity of the INEEL and on-site areas open for permit grazing (AC3088).

To evaluate potential occupational risks from exposure to soil, it is assumed that both current and future workers at the sites will only be exposed to contamination from the top 15 cm (6 in) of soil for the soil ingestion, inhalation of fugitive dust and VOC exposure routes. For the evaluation of external radiation exposure, radionuclide activities present in the top 1.2 m (4 ft) of soil will be used. This analysis method is referred to as the occupational nonintrusion exposure scenario, and all occupational exposure scenario analyses in the OU4-13 BRA will include an evaluation of this exposure scenario.

For the purposes of the BRA, it is assumed that future residents will construct 3 m (10 ft) basements beneath their homes. As a result, all contamination detected in the upper 3 m (10 ft) of each release site will be evaluated for surface pathway exposures. This analysis method will hereafter be referred to as a "residential intrusion scenario," and all residential exposure scenario analysis in the OU 4-13 BRA will include the residential intrusion assumption.

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